

Integration of Demilitarization Contractors and Recyclers – Collateral Benefits of On-Site Training of Recyclers

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Abstract

Gradient Technology, Bedford Metals, and Demil Metals, Inc. formed and are currently operating a joint team in order to fully manage the safe demilitarization and recycling of explosive and metal components (R 3). This unique team effort provides enhanced process safety as a fully integrated team handles the resource recovery and reclamation of the munitions from the start of the demilitarization process through to the certificate of destruction at the end. Operating as a joint venture, the team has complete transparency throughout the different companies. Historically, this level of transparency has been difficult to achieve with subcontracted efforts. Gradient Technology took the lead in performing on-site ordnance recognition training to the recyclers. This training included general ordnance recognition and identification beyond the munitions that Gradient Technology processes. The collateral benefit of the extended training has allowed the recyclers to better identify and evaluate potential ordnance hazards in scrap metal that they receive from other sources. The result of the training over the last few years has been zero lost-time accidents related to handling ordnance and the identification of several suspect items that were referred to the local authorities. Although the DOD has an excellent safety record with recycling MPPEH, there is still benefit in providing advanced ordnance recognition training to recyclers.

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Introduction

Several years ago, Gradient Technology started a large scale demilitarization line for the reverse manufacturing of large caliber U.S. Navy ordnance. Like most companies, we knew little about the scrap metal business other than “the stuff went away.” However, we soon realized that our moral responsibility extended beyond placing the different metals in the correct bins. We have since worked very closely, and even teamed, with our recycling chain to be more fully integrated. In this new era of diminishing Federal budgets and the looming loss of corporate memory from a shrinking industry base, it is necessary for everyone to look out for each other when handling ordnance materials.

Recycling ordnance scrap is a concern for both the defense community as well as the recycling community. Like all relationships it can be both beneficial and problematic at times. The relationship between the military and recycler has occasionally become slightly strained. Mistakes, misunderstandings, and miscommunications have resulted in a number of MPPEH related issues and events that have been undesirable for both communities. On the other hand, it is rare to have problems when the military and qualified recyclers deal directly with each other.

Neither the defense nor the recycling community benefits from MPPEH mistakes. There have been a relatively small number of accidents and near-misses in the defense-recycling relationship both here and abroad. The primary reason for this excellent safety record is that the DoD has done an excellent job of preventing live ordnance or explosively contaminated scrap from being released to legitimate recyclers.¹

However, the five-fold increase in scrap metal prices over the last few years has encouraged illegitimate recyclers (scavengers) to take greater risks in the search for metals to sell. The scavengers often co-mingle hazardous materials with legitimate scrap materials, which are then passed on to legitimate recyclers. The Institute of Scrap Recycling Industries, Inc. has since recommended that their recycling members refuse to deal with military scrap unless exceptional precautions are taken and full documentation provided.²

Environmental Benefits of Recycling

A close working relationship between the DOD and recyclers is beneficial to both parties. The Department of Defense needs to dispose of over a million tons of steel and nonferrous metals each year. These sales generate cash that partially offsets the costs of operations. If these materials were not recycled, the scrap would have to be landfilled with the associated environmental impacts.

Recycling is very good for the environment. The United States annually recycles more than 90 million tons of ferrous and nonferrous metals. The environmental implications are enormous. Today, two-thirds of domestically produced steel is made from recycled scrap steel and 60% of the nonferrous metals produced in the United States come from recycled sources. Worldwide,

¹ The EPA has listed a number of ordnance incidents since 1942 at <http://www.epa.gov/fedfac/pdf/2001UXOreport.pdf>

² Carter, Chelsea J., “Military Cracks Down on Scrap-Metal Scavengers,” *Associated Press*, 13 May 2008. <http://www.wtop.com/?nid=104&sid=1402991> and http://www.scrap.org/ArticlesArchive/2008/May-June/top_stories.htm

40% of the world's copper comes from recycled material. Recycling scrap iron saves 74% of the energy needed to make virgin steel. The energy savings is even greater with some non-ferrous metals. Recycled aluminum saves 95% of the energy necessary for virgin material, copper 85%, zinc 63%, and lead 60%.³

Not only does recycling reduce the amount of direct energy required but it also translates to reductions in the energy-related carbon footprint and greenhouse gas (GHG) emissions. Each ton of recycled steel saves almost two tons of carbon dioxide⁴ and each ton of recycled aluminum saves approximately ten tons of GHG emissions.⁵ Furthermore, there are yet additional environmental benefits. Recycling one ton of steel, for example, conserves 120 lbs of limestone, 2,500 lbs of iron ore, and 1,400 lbs of coal with an 86% reduction in air pollution, 40% in water use, and 76% in water pollution.⁶ What more can one ask of a process? Recycling is good for the DOD and very good for the environment.

Scrap Processor Training

The scrap military metals coming from DRMO, range clearance, or demilitarization operations are thoroughly inspected by DoD personnel with specialized training. The probability of an inadvertent live round showing up in a scrap yard from these legitimate sources is extremely low. The high level of process safety achieved by the DoD is substantial and is, unfortunately, rarely complimented.

However, the low probability of occurrence cannot outweigh the high consequences of an accidental initiation from an anomaly. Mistakes do happen, even with the best of systems. Murphy's Law observes that any policy, procedure, or human action is, regrettably, fallible.⁷ Even with the best of efforts, there is a probability, however small, that an incorrect item will get past the inspection process. Human reliability models on decision making identify a number of factors that affect the reliability of human decisions.⁸ The DoD has sought to optimize each and every one of these factors through explicit procedures, extensive training, and independent redundant inspections. Each one of these actions significantly lowers the human error probability.

DoD 4140.62 MPPEH policy⁹ states that MDAS requires redundant 100% inspections by technically qualified personnel and that a chain of custody is tightly maintained. Assuming that the sorting of MPPEH by an ordnance specialist is a "completely familiar, well-designed, highly practiced, routine task occurring several times per hour, performed to highest possible standards by a highly motivated, highly trained and experienced person, totally aware of implications of failure, with time to correct potential errors" should yield a human error probability of 0.0004

³ Institute of Scrap Recycling Industries, www.isri.org

⁴ "A Policy to Reduce Steel-Related Greenhouse Gas Emissions," World Steel Organization, <http://www.worldsteel.org/index.php?action=storypages&id=275>

⁵ "Recycling," <http://www.eaa.net/en/about-aluminium/recycling/> Note: measured in CO₂ equivalents.

⁶ See http://www.nerc.org/documents/environmental_benefits_calculator.html

⁷ "Murphy's Law was Born Here," *Desert Wings*, (Edwards AFB) 03 Mar 1978; See also Spark, Nick T., *A History of Murphy's Law*, (Los Angeles, CA: Periscope Film, 2006).

⁸ For example, see NUREG/CR-6883 *The SPAR-H Human Reliability Analysis Method*, Aug 2005.

⁹ DoD Instruction 4140.62 *Material Potentially Presenting an Explosive Hazard*, 25 Nov 2008.

according to published research.¹⁰ Given that there is an independent, redundant inspection, the probability product of two sequential human errors should be less than 1.6×10^{-7} or one error in 6.25 million items.

Several years ago, Gradient Technology determined that the best way to protect their recycling chain was to actively participate in the safety training by teaching scrap metal processors so as to add one more set of trained eyes to the process. The training provided by Gradient Technology is not meant to be a substitute for the proper demilitarization and inspection processes currently undertaken under the auspices of the DoD. The DoD does a great job at protecting the public and the additional training is only meant as an additional layer of protection.

Unfortunately military scrap is such a small part of the recycling market that many scrap dealers don't deal with military scrap materials on a regular basis. In addition, there is a high turnover of workers in the scrap industry. The majority of the scrap metal recycling companies are privately owned family firms employing a very small number of permanent employees.¹¹ Consequently, Gradient Technology chose to work with two companies with a serious commitment to processing military scrap, Demil Metals and Bedford Recycling. These two companies handle large volumes of military scrap on a daily basis, are much more likely to encounter an anomaly, and have a stable workforce. With advanced training, their personnel are much more likely to recognize an anomaly.

Training Objectives

Although the main focus of the training is to identify a "positive" item, also known as a live or otherwise hazardous item, we also wanted to focus on minimizing "false positives," or an inert item misidentified as being hazardous. The reduction in "false positives" is critical since an EOD specialist cannot be sent out to chase every item that *might* be "hazardous." The cardinal rule remains, however, "if in doubt, call!"

Along with showing photographic information on recognizing hazardous items, we included a graphical "decision tree" to assist in the process. A rough overview of the decision tree for handling scrap MPPEH is attached as Appendix A.

Results of Training

So far, the workers have identified about a half-dozen "suspect" items that have required additional analysis. Virtually all of these were resolved by following the decision tree, testing using the approved colorimetric test kit (such as *Expray*), or discussing the item with an ordnance specialist.¹² However, at least one of the items could not be resolved and was referred to the local authorities. The items were suspected to be inert training warheads, but it was referred to the local authorities to make the ultimate determination.

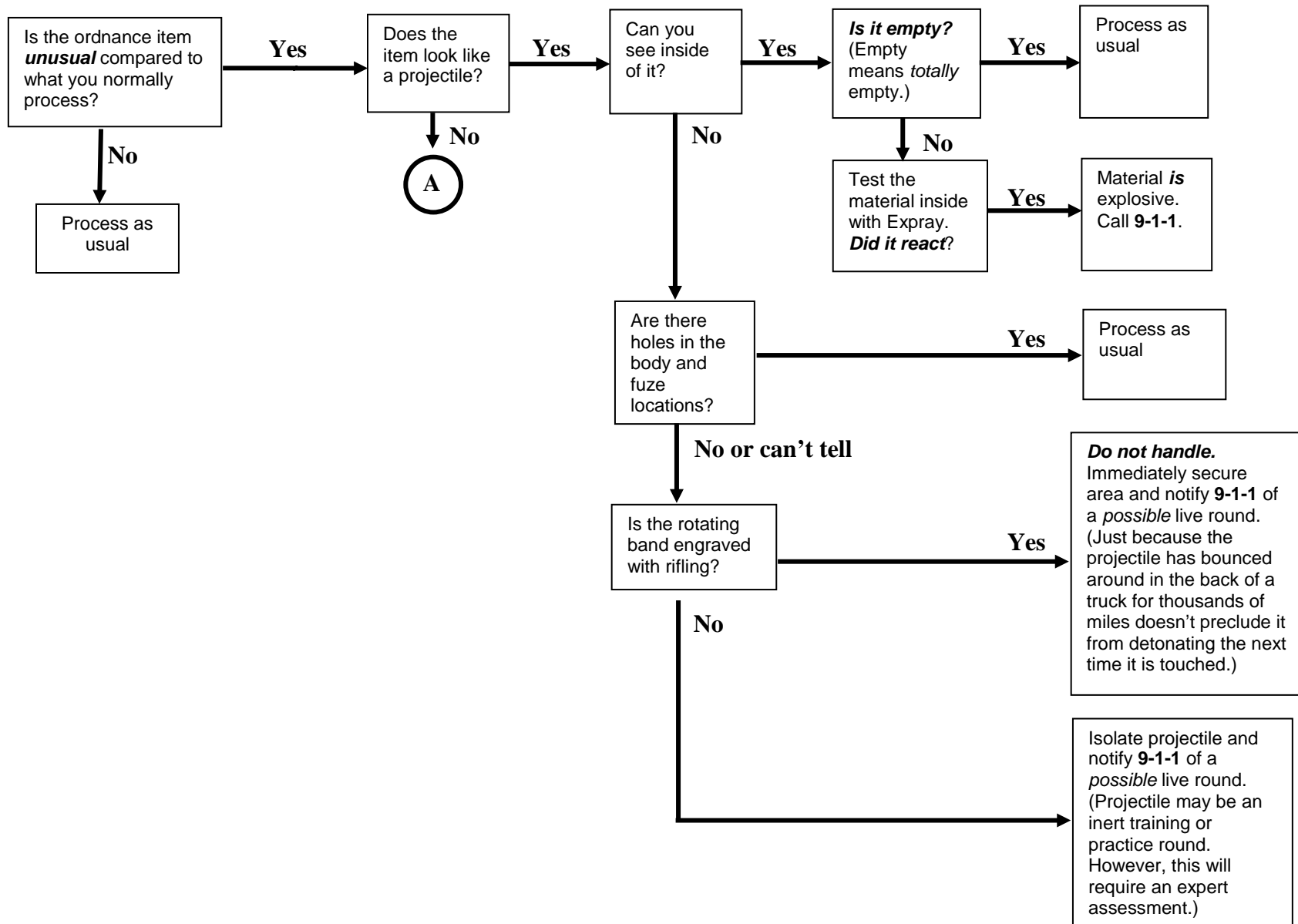
¹⁰ NUREG/CR-6883 *The SPAR-H Human Reliability Analysis Method*, Aug 2005, Table 3-2: Mixed-Task Base Rate Comparison, pg 44.

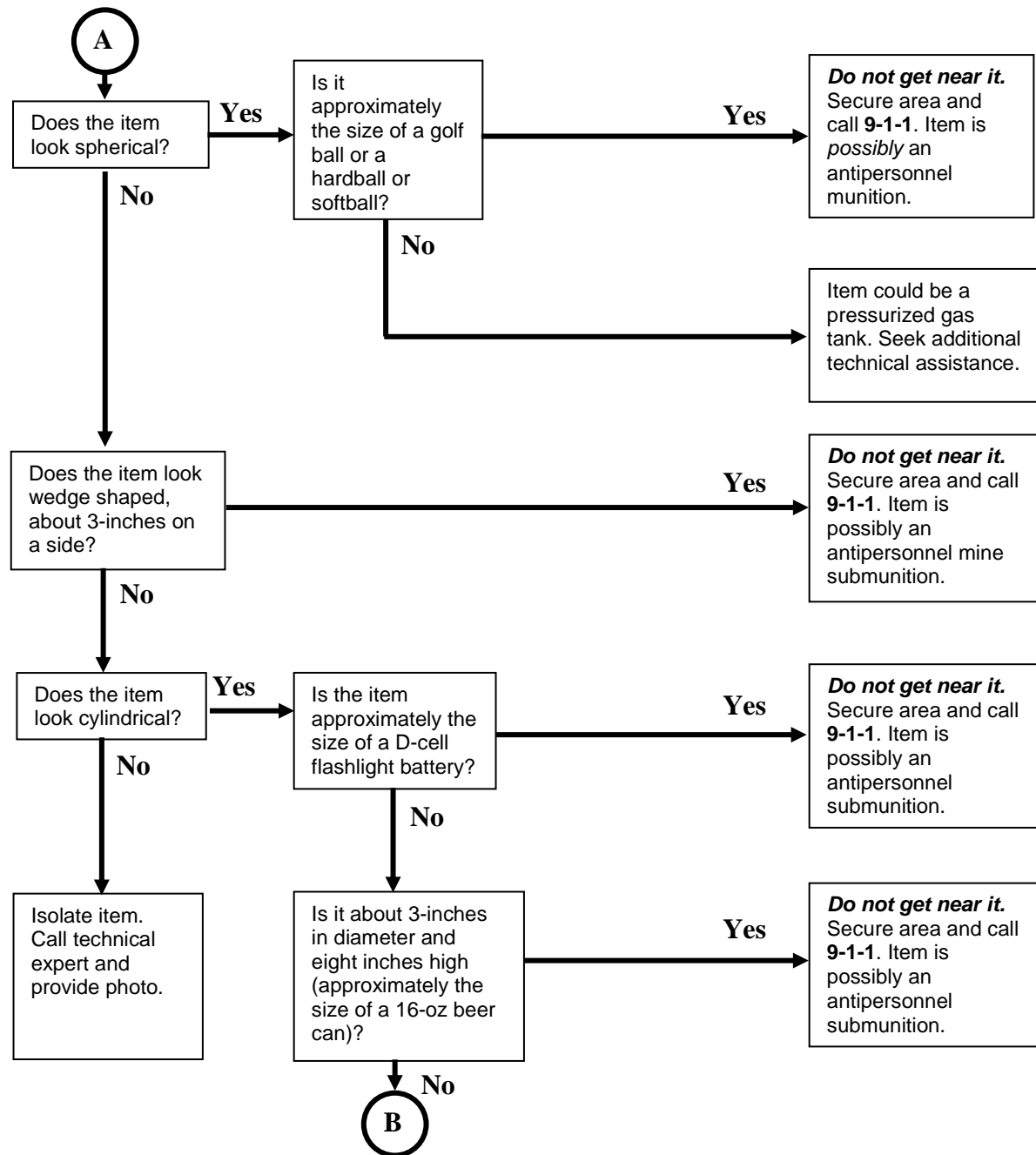
¹¹ "The Scrap Metal Boom," *Bullion Vault*, 14 February 2008, <http://goldnews.bullionvault.com/node/1916>.

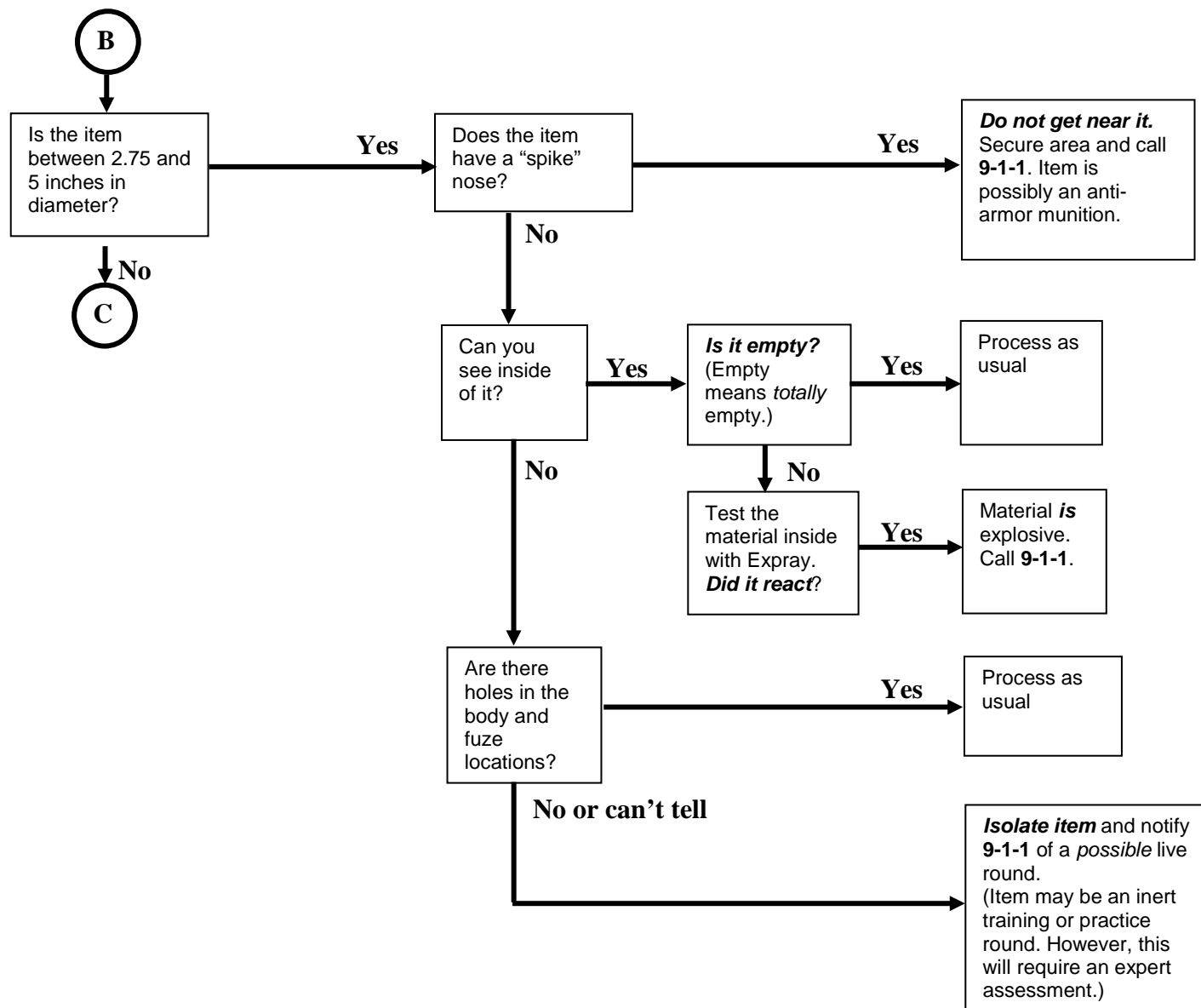
¹² <http://expray.plexsci.com/site/index/products/kits/explosionkits.html>

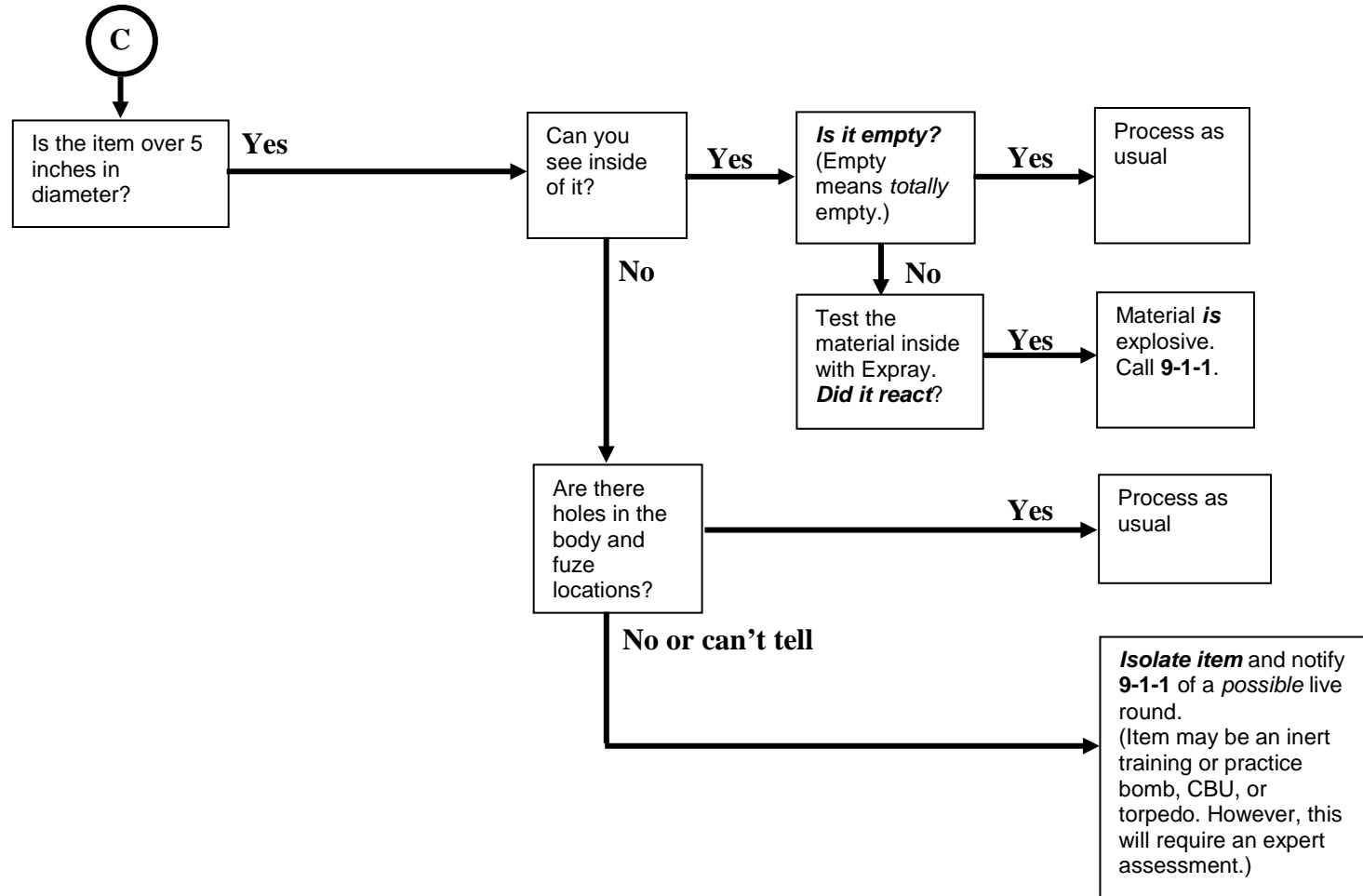
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APPENDIX A – Rough Overview of Scrap MPPEH Decision Tree









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Murphy's Law

“If anything can go wrong, it will”



Murphy's Law

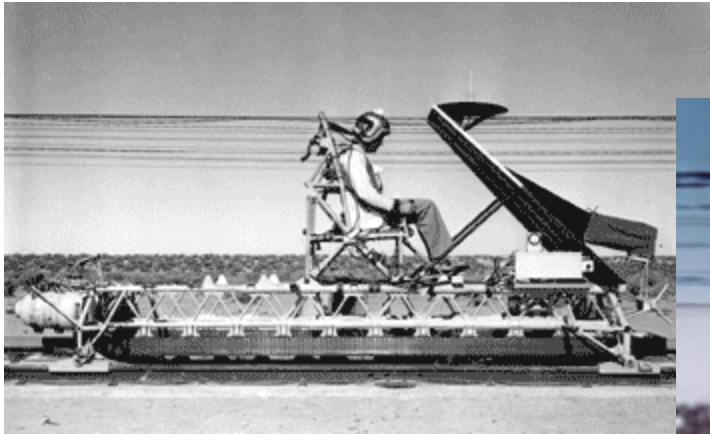
- Uttered by Capt. Edward Murphy, Jr. in 1949, but formalized by Capt. John Stapp, MD (PM - Project MX981) at Edwards AFB

Murphy's Law

- ❑ Uttered by Capt. Edward Murphy, Jr. in 1949, but formalized by Capt. John Stapp, MD (PM - Project MX981) at Edwards AFB
- ❑ Capt. Stapp originally had a different concept of Murphy's Law:

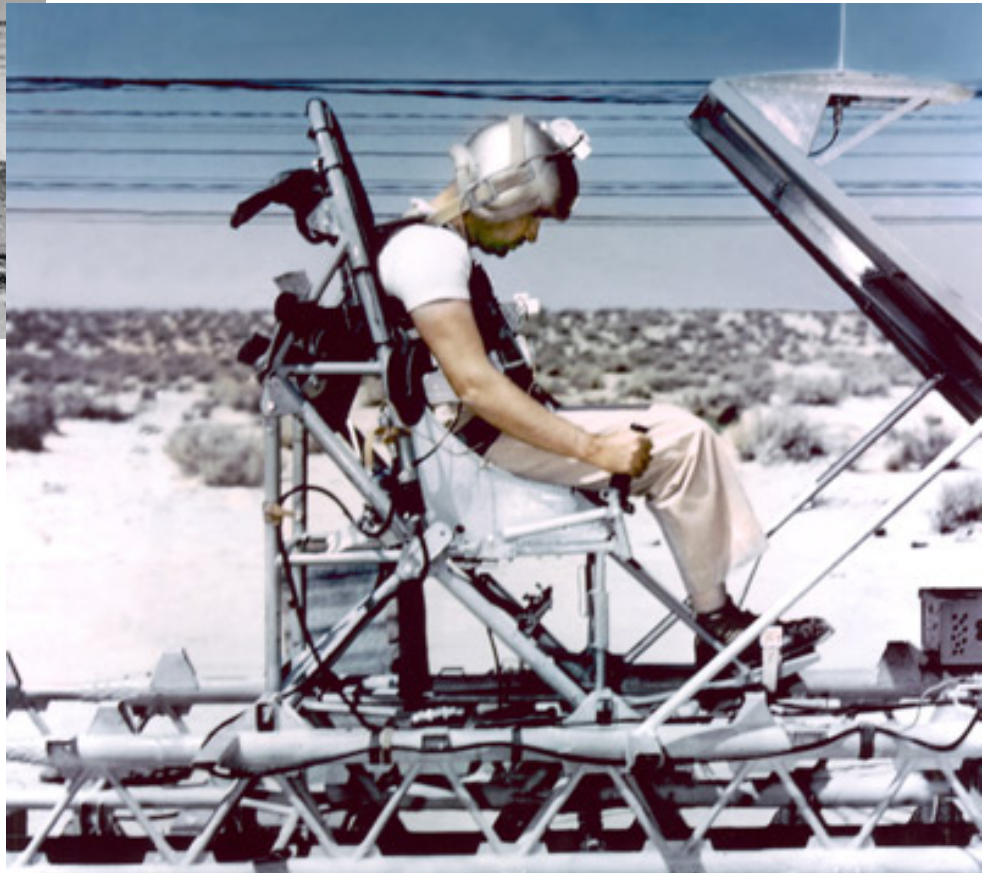
“...a belief that if one can predict the bad things that *might* happen, steps can be taken so that they can be avoided.”

Project MX981 (Capt. John Stapp)



Rocket acceleration /
deceleration human endurance
tests at Edwards AFB

Photos: EAFB Historical Office



Capt. Stapp's Vision

- John Stapp also believed that the safety community had an obligation to reduce injuries and suffering wherever they saw it
 - He transitioned much of his work on biomechanics in aircraft crashes to automobiles
 - The seatbelts in your car are due to John Stapp
 - The *Stapp Car Crash Conferences* (www.stapp.org) continue in John's honor



The Art of Safety

- Safety is the art of predicting by analysis what can possibly go wrong and coming up with a way of preventing such an occurrence
 - Safety is often prioritized by risk-based analyses to target unacceptable (high risk) behaviors or situations
 - Illogically, some high risk behaviors or situations are quite acceptable to the public

Victoria Falls Swimming Pool

That's a 108 meter (350-ft) drop over the edge



P.S. - They average about one fatality per year

W. Edwards Deming's Views on Proper Corporate Behavior

- ❑ Select companies who are *committed* to the long range goals rather than just short term profits
- ❑ Create and stabilize *relationships*
- ❑ *Communicate, communicate, communicate*

Why Integrate with Recyclers?

- Responsible companies logically need to look out for each other's safety
 - Gradient Technology demilitarizes ordnance
 - GT use recyclers to recycle scrap ordnance
 - GT will ultimately suffer if there is a problem (GT related or not) at a recycler
 - Therefore: Gradient Technology needs to work with the recyclers to make sure their processes are safe

Recycling Scrap Ordnance



Other Sources of Scrap Ordnance

- ❑ Legitimate range residues from active and inactive range remediation efforts
- ❑ Ordnance items accidentally left in combat vehicles being scrapped or in legitimate scrap
- ❑ Stolen scrap metal from military installations by “coyotes” (illegal scrappers) and mixed with commercial scrap

Recyclers are Tightening Up Safety

- “... *most [illegal] scrappers arrested in the past several years appeared to be either illegal immigrants or drug users looking for easy money*” – Associated Press
- The Institute of Scrap Recycling Industries (ISRI) has now requested their members *refuse all military scrap* unless it is properly documented



Chain of Custody for Safety

- ❑ Qualified recyclers work closely with the steel mills so that the ordnance lots
 - Remain segregated
 - Remain traceable
 - Generate certificates of destruction when steel is melted down
- ❑ Prevents undocumented or un-inspected materials from accidentally “sneaking” in

Possibility of Human Error

- Human error probability (HEP) for inspection [per NUREG/CR-6883] given:
 - “...completely familiar, well-designed, highly practiced, routine task occurring several times per hour, performed to highest possible standards by a highly motivated, highly trained and experienced person, totally aware of implications of failure, with time to correct potential errors”

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= 0.0004

Possibility of Human Error

- DOD Instruction 4140.62 requires redundant 100% inspections of MPPEH before declaring it MDAS (material documented as safe)

$$\begin{aligned} 200\% \text{ inspection} &= 0.0004 \times 0.0004 \\ &= 0.00000016 \text{ HEP} \\ &= 1 \text{ in } 6,250,000 \text{ items} \end{aligned}$$

Possibility of Human Error

- ❑ DOD HEP of 0.00000016 supplies an adequate safety level
- ❑ However, providing a third 100% independent inspection at the recycler *would be even better* (recycler has to handle it anyway)

$$\begin{aligned} 300\% \text{ inspection} &= 0.0004 \times 0.0004 \times 0.0004 \\ &= 0.000000000064 \text{ HEP} \\ &= 1 \text{ in } 15,625,000,000 \text{ items} \end{aligned}$$

Training Overview

- Recyclers require only sufficient training to identify that an *anomaly* exists
 - They don't need the level of expertise required to *fully classify* the item
 - They don't need the level of expertise required to *render-safe* a suspect item
 - The responsibility for a “live round” doesn't pass to the recycler



Ordnance Training

- Most safety awareness training consists of “if you see ordnance, leave it and 9-1-1”
 - Great for the general public
 - Not exactly applicable for those recycling ordnance and military items

Typical Items at Recycling Yard



Generalized Training

- ❑ The generalized training provided was not intended to serve every possibility
 - Every operation will have specific differences
 - Some ordnance items are so unique that specialized training may be required
- ❑ When in doubt – **CALL SOMEONE!**
 - We tell recyclers to call an ordnance specialist or 9-1-1 if there are ANY questions about an item



Basic Training Concepts

- Does the item *look familiar* (compared to what you normally process)?
 - Can you see inside and verify that it is **EMPTY**?

There should be holes!

- Can you *see into it*?
 - There should be one or more holes into the body of the item
 - Is it **EMPTY**?



Is it Empty?

- Is it empty?
(Empty means **empty**!)
 - If totally empty, process as usual...
 - If not, then test it!

This one had a waxy, reddish-tan filler....



Field Test Kit Testing

- If it isn't empty, test using an “approved PEP test kit”
 - If positive, call 9-1-1
 - If negative, process as usual...



Does it have a Fuze on it?

- ❑ Items with fuzes on them require additional inspection
 - Are there holes in the projectile below the fuze body (booster)?
 - ❑ If there are holes – process as usual
 - ❑ If there aren't, call for assistance before processing



Basic Training Concepts

- Does the item *look familiar* (compared to what you normally process)?
 - Can you see inside and verify that it is **EMPTY**?
 - If *No*: Then is the shape of the item
 - Spherical?
 - Wedge Shaped?
 - Cylindrical?
 - These items are potentially *very* dangerous

Spherical = Not Good



If found in a recycling yard, don't touch! Call 9-1-1

Wedge Shape = Not Good



If found in a recycling yard, don't touch! Call 9-1-1

Cylindrical = Not Good



M42/M46/M77



BLU-97



Mk118



M456

If found in a recycling yard, don't touch! Call 9-1-1

Some Hazards Aren't Explosive

- High pressure vessels can also cause injuries
 - Pressure vessels should be considered pressurized until otherwise proven
 - Having a big visible hole in one would be nice




Results

- Over the past few years since training started the number of “suspect” items identified by recycling personnel went up significantly
 - Several dozen items referred to higher levels for further inspection or testing
 - Several items ultimately referred to the local authorities
 - Most likely inert target projectiles that were not properly punched / marked / drilled



Benefits

- Working closely with the recyclers allows Gradient Technology to better participate in the integrated process
- Protecting the recyclers through additional training provides Gradient Technology a greater assurance of process continuity and the ability to recycle our scrap
 - Like it or not, if one part of the system fails, we all fail



Not the End,
just the another step in the process...